

DAVID H. BAILEY

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Academic Background

B. S. 1972, mathematics, Brigham Young University
Ph. D. 1976, mathematics, Stanford University

Professional Society Memberships

Society for Industrial and Applied Mathematics (SIAM)
Institute for Electrical and Electronic Engineers (IEEE)
Association for Computing Machinery (ACM)

Major Awards

1. *The 1993 Sidney Fernbach Award.* This award is presented by the IEEE Computer Society at the annual Supercomputing conferences for outstanding contributions to the field of high performance computing. The citation mentioned work in FFTs, matrix multiplication, multiple precision arithmetic, and the NAS Parallel Benchmarks.
2. *The 1993 Chauvenet Prize.* This award is presented by the Mathematical Association of America (MAA) at the annual AMS-MAA conferences, for outstanding mathematical articles. Past recipients include many well-known mathematicians of the twentieth century. The article cited for this award was “Ramanujan, Modular Equations and Approximations to Pi”, which was co-authored by Jonathan Borwein, Peter Borwein and myself (see paper 9 below).
3. *The 1993 Merten Hasse Prize.* This award, which is also granted by the MAA, is presented annually for outstanding mathematical articles. The article cited for this award was “Ramanujan, Modular Equations and Approximations to Pi” (see paper 9 below).
4. *The 1995 H. Julian Allen Award.* This award is given annually by NASA Ames Research Center for outstanding research work and papers. The article cited for this award was “The NAS Parallel Benchmarks”, co-authored with several other NASA scientists (see papers 19 and 23 below).

Lawrence Berkeley National Laboratory, 1998 - present:

1. *High precision computation.* Working under a Laboratory Director's R&D grant, I have developed techniques, software and applications for very high precision arithmetic calculations. This work has been done in collaboration with researchers in the U.S., Canada, the United Kingdom, as well as at LBNL and U.C. Berkeley. One breakthrough here is a new algorithm for integer relation detection, suitable for implementation on a parallel computer system (see paper 52 below). Another is some new results on the randomness of the binary digits of pi and other mathematical constants (see paper 49 and 50). The "PSLQ" algorithm, developed by Helaman Ferguson, Stephen Arno and myself, has been recently named one of ten "algorithms of the century" by the editors of *Computing in Science and Engineering* (see papers 42 and 46).
2. *Supercomputer performance.* Several researchers at LBNL and myself are doing research to better understand the factors that limit the sustained and effective performance of modern high-end computing systems. To this end we have developed a new benchmark test, known as the "ESP" test, to measure system-level performance (see papers 45, 47 and 51 below).
3. *Supercomputing '99.* I just completed serving as Technical Papers Chair for Supercomputing '99. The annual Supercomputing meetings are the premier conference series in the field of high performance computing. In addition, I served as Chair of the 1998 and 1999 Gordon Bell Prize selection committees.
4. *NERSC-3 procurement.* I participated in the NERSC-3 supercomputer procurement, including defining benchmarks and system requirements, preparing the Request for Proposals document, evaluating proposals, and negotiating with vendors. The result of this effort is a large contract (approximately \$30 million) to IBM for a 3 Tflop/s parallel computer system, the first phase of which has now been installed. I have also participated in a procurement for a cluster system.
5. *NERSC-MSRI Workshops.* I helped organize workshops, conducted jointly by NERSC and the Mathematical Sciences Research Institute (MSRI), including "Minorities in Applied Mathematics", Sept. 1998, "Parallel Symbolic Computation", Oct. 1998, and the MSRI Workshop on Algorithmic Number Theory, Fall 2000. I am currently on the Organizing Committee for the MSRI Workshop on Algorithmic Number Theory, a semester-long program during Fall 2000.

NASA Ames Research Center, 1984-1998:

1. *Supercomputer performance.* I was a co-author of the NAS Parallel Benchmarks, which are now widely used as a metric for assessing the performance of scientific computer systems. One observer in the field remarked in 1994 that the NAS Parallel Benchmarks had done more to promote measurable progress in the field of high performance computing than any other development of the previous five years (see papers 19 and 23 below).
2. *Numerical algorithms.* I authored numerous papers on various numerical algorithms for modern computer systems. For example, some techniques I developed for performing fast Fourier transforms (FFTs) on parallel hierarchical memory systems have been incorporated into widely used library routines (see papers 5, 6 and 12 below).

3. *Petaflops computing.* For several years I participated with a group of colleagues in studying the issues of future petaflops-scale computer systems that will be available in the 2010 time frame. In 1997, I chaired a workshop on petaflops algorithms.
4. *High-End Computing Working Group.* For three years I served on the High-End Computing Working Group, a national-level subcommittee under the U.S. Government's Committee on Computing, Information and Communications. I authored several reports and research plans for federally-funded research in the field.
5. *Research Group Leader.* For three years I served as the leader of a group in the NAS Systems Division at NASA Ames that included 25-30 researchers in algorithms, software tools, semiconductor device modeling and nanotechnology.
6. *Procurements.* I served on at least two key NASA computer system procurement committees. One of these, which I personally led, involved the procurement of a large IBM parallel computer system, together with a research program in computational aeroscience, with a total funding level of \$22 million.

Professional Community Activities

1. Program co-chairman, 1988 International Conference on Parallel Processing.
2. Deputy program chairman, Supercomputing '90.
3. Program committee, Supercomputing '91 and Supercomputing '92.
4. Program committee, International Conference on Supercomputing (1991, 1992 and 1993).
5. Editor, IEEE Transactions on Parallel and Distributed Computing (1990 - 1993);
6. Tutorial committee, Supercomputing '93 and Supercomputing '94.
7. Program committee, SIAM Parallel Processing Conference (1995).
8. Chair, Petaflops Algorithm Workshop (1997).
9. Program committee and tutorial committee, Supercomputing '97.
10. Board of governors, Institute for Mathematics and Applications (1996 - 1998).
11. Chair, Sidney Fernbach award subcommittee (1995); member (1996 - 1998).
12. Chair, MSRI Parallel Symbolic Computation workshop (1998).
13. Technical Papers Chair, Supercomputing '99 Conference, 1999.
14. Chair, Gordon Bell Prize selection committee (1998 - 1999); member (1996 - 1997).
15. Program committee, Petaflops-2 Conference (1999).
16. Governing board, Supercomputing SIG, Association for Computing Machinery (1993 - 1999).
17. Review Panel, DoE ASCI University Alliance program (1998 - 2000).
18. Review Committee, NSF Information Technology Research proposal review panel, 2000.
19. Organizing Committee, MSRI Workshop on Algorithmic Number Theory, semester-long program (Fall 2000).
20. Program Committee, International Parallel and Distributed Processing Symposium (2000).
21. RIACS Science Council (1999-present).
22. Board of editors, Journal of Supercomputing (1994-present).
23. Board of editors, International Journal of High Speed Computing (1992-present).

Recent Invited Talks, Tutorials and Panel Presentations

1. "Is Scalable Parallel Computing a Myth?", panel presentation, SIAM Conference on Parallel Processing (Feb. 1995).
2. "Finding New Mathematical Identities by Supercomputer", minisymposium talk, SIAM Conference on Parallel Processing (Feb. 1995).
3. "Recognizing Numerical Constants", invited talk, Workshop on Organic Mathematics (Dec. 1995).
4. "RISC Processors and Scientific Computing", tutorial, Supercomputing '95 (Dec. 1995). This was the most popular tutorial at the conference.
5. "Hot Chips for High Performance Computing", tutorial, Supercomputing '96 (Nov. 1996). This was the most popular tutorial at the conference.
6. "Scientific and Business Computing: Is There Common Ground?", panel presentation, International Parallel Processing Symposium (Mar. 1998).
7. "Challenges of Future High-End Computing", invited talk, High Performance Computing Systems '98 (May 1998).
8. "Challenges of Future High-End Computing", invited presentation, 1998 International Computational Accelerator Physics Conference (Sep. 1998).
9. "Findings and Recommendations for Petaflops Computing", panel presentation, Petaflops-2 Conference (Feb. 1999).
10. "Discovering New Formulas of Math and Physics Using High Precision Integer Relation Computations", invited seminar talk, University of Western Ontario (Nov. 1999).
11. "Are the Digits of Pi Random?", invited seminar talk, Center for Computing Sciences (Apr. 2000).
12. "Challenges of Future High-End Computing, invited plenary talk, SP World Conference (Jun. 2000). This talk was reported in the publication InfoWorld -- see the URL <http://www.infoworld.com/articles/hn/xml/00/06/05/000605hnibmsuper.xml>

Publications

These are listed in chronological order, with the most recent listed last. Online copies of many of these papers are available from the author's web site (see above).

1. David H. Bailey, "Vector Computer Memory Bank Contention", *IEEE Transactions on Computers*, vol. C-36, no. 3 (Mar. 1987), pg. 293-298.
2. David H. Bailey, "A High Performance Fast Fourier Transform Algorithm for the Cray-2", *Journal of Supercomputing*, vol. 1, no. 1 (Spring 1987), pg. 43-60.
3. David H. Bailey, "The Computation of Pi to 29,360,000 Decimal Digits Using Borweins' Quartically Convergent Algorithm", *Mathematics of Computation*, vol. 50, no. 181 (Jan. 1988), pg. 283-296.
4. David H. Bailey, "Numerical Results on the Transcendence of Constants Involving Pi, E, and Gamma", *Mathematics of Computation*, vol. 50, no. 181 (Jan. 1988), pg. 275-281.
5. David H. Bailey, "A High-Performance FFT Algorithm for Vector Supercomputers", *Journal of Supercomputer Applications*, vol. 2, no. 1 (Spring 1988), pg. 82-87.
6. David H. Bailey, "Extra-High Speed Matrix Multiplication on the Cray-2", *SIAM Journal on Scientific and Statistical Computing*, vol. 9, no. 3 (May 1988), pg. 603-607.

7. Don A. Calahan and David H. Bailey, "Measurement and Analysis of Memory Conflicts on Vector Multiprocessors", *Performance Evaluation of Supercomputers*, Joanne L. Martin, ed., North-Holland, 1988, pg. 83-106.
8. David H. Bailey and Helaman R. P. Ferguson, "A Strassen-Newton Algorithm for High-Speed Parallelizable Matrix Inversion", *Proceedings of Supercomputing 1988*, Oct. 1988, pg. 419-424.
9. Jonathan M. Borwein, Peter B. Borwein and David H. Bailey, "Ramanujan, Modular Equations, and Approximations to Pi", *American Mathematical Monthly*, Mar. 1989, pg. 201-219. This paper was cited for both the Chauvenet Prize and the Merten Hesse Prize (see above).
10. David H. Bailey and Heleman R. P. Ferguson, "Numerical Results on Relations Between Numerical Constants Using a New Algorithm", *Mathematics of Computation*, vol. 53, no. 188 (Oct. 1989), pg. 649-656.
11. David H. Bailey, Horst D. Simon, John T. Barton and Martin J. Fouts, "Floating Point Arithmetic in Future Supercomputers", *International Journal of Supercomputer Applications*, vol. 3, no. 3 (1989), pg. 86-90.
12. David H. Bailey, "FFTs in External and Hierarchical Memory", *Journal of Supercomputing*, vol. 4, no. 1 (Mar. 1990), pg. 23-35.
13. David H. Bailey, Eric Barszcz, Rod A. Fatoohi, Horst D. Simon and Sisira Weeratunga, "Performance Results on the Intel Touchstone Gamma Prototype", *Proceedings of the Fifth Distributed Memory Computing Conference*, Apr. 1990, pg. 1236-1245.
14. David H. Bailey, "In Response to the Fate of Fortran-8X", *Communications of the ACM*, vol. 33, no. 4 (Apr. 1990), pg. 391-392.
15. David H. Bailey, King Lee, and Horst D. Simon, "Using Strassen's Algorithm to Accelerate the Solution of Linear Systems", *Journal of Supercomputing*, vol. 4., no. 4 (Jan. 1991), pg. 357-371.
16. David H. Bailey, "Twelve Ways to Fool the Masses When Giving Performance Results on Parallel Computers", *Supercomputing Review*, Aug. 1991, pg. 54-55. This article has been cited many times, including *The New York Times*, Sep. 22, 1991, pg. 14.
17. David H. Bailey and Paul N. Swarztrauber, "The Fractional Fourier Transform and Applications", *SIAM Review*, vol. 33 no. 3 (Sept. 1991), pg. 389-404.
18. David H. Bailey, "Performance of Two of the NAS Parallel Benchmarks", *Proceedings of Supercomputing 1991*, Nov. 1991, pg. 166-173.
19. D. H. Bailey, E. Barszcz, J. T. Barton, D. S. Browning, R. L. Carter, L. Dagum, R. A. Fatoohi, P. O. Frederickson, T. A. Lasinski, R. S. Schreiber, H. D. Simon, V. Venkatakrishnan and S. K. Weeratunga, "The NAS Parallel Benchmarks", *International Journal of Supercomputer Applications*, vol. 5, no. 3 (Fall 1991), pg. 63-73. This paper was cited for both the Sidney Fernbach Award and the H. Julian Allen Award (see above).
20. David H. Bailey, "Misleading Performance Reporting in the Supercomputing Field", *Scientific Programming*, vol. 1, no. 2 (Winter 1992), pg. 141-151.
21. David H. Bailey, "How Useful Are Today's Parallel Computers?", *Computers in Physics*, vol. 6, no. 2 (Mar./Apr. 1992), pg. 216.
22. David H. Bailey, Eric Barszcz, Leo Dagum and Horst D. Simon, "NAS Parallel Benchmark Results", *Proceedings of Supercomputing 1992*, Nov. 1992, pg. 386-393.
23. David H. Bailey, Eric Barszcz, Leo Dagum and Horst D. Simon, "NAS Parallel Benchmark Results", *IEEE Parallel and Distributed Technology*, premier issue, Feb. 1993, pg. 43-51. Several updates have been published elsewhere.

24. David H. Bailey, "Experience with Parallel Computers at NASA Ames", *International Journal of High Speed Computing*, vol. 5, no. 1 (1993), pg. 51-62.
25. David H. Bailey, Robert Krasny and Richard Pelz, "Multiple Precision, Multiple Processor Vortex Sheet Roll-Up Computation", *Proceedings of the 1993 SIAM Conference on Parallel Processing*, May 1993, SIAM, Philadelphia, pg. 52-56.
26. David H. Bailey, "Multiprecision Translation and Execution of Fortran Programs", *ACM Transactions on Mathematical Software*, vol. 19, no. 3, Sept. 1993, pg. 288-319.
27. David H. Bailey, "RISC Microprocessors and Scientific Computing", *Proceedings of Supercomputing 1993*, IEEE Computer Society, Nov. 1993, pg. 645-654.
28. David H. Bailey, Jonathan M. Borwein and Richard Girgensohn, "Experimental Evaluation of Euler Sums", *Experimental Mathematics*, vol. 3, no. 1 (1994), pg. 17-30.
29. ParkBench Committee [which included DHB], "Public International Benchmarks for Parallel Computers", *Scientific Programming*, vol. 3, no. 2 (Summer 1994), pg. 100-146.
30. David H. Bailey and Paul N. Swarztrauber, "A Fast Method for the Numerical Evaluation of Continuous Fourier Transforms", *SIAM Journal on Scientific Computing*, vol. 15, no. 5 (Sept. 1994), pg. 1105-1110.
31. Paul N. Swarztrauber and David H. Bailey, "Efficient Detection of a Continuous Wave Signal with a Linear Frequency Drift", *SIAM Journal of Scientific Computing*, vol. 16 (Sept. 1995), pg. 1233-1239.
32. David H. Bailey, "A Fortran-90 Based Multiprecision System", *ACM Transactions on Mathematical Software*, vol. 21, no. 4 (Dec. 1995), pg. 379-387.
33. David H. Bailey, "Unfavorable Strides in Cache Memory Systems", *Scientific Programming*, vol. 4 (1995), pg. 53-58.
34. David H. Bailey, Jonathan M. Borwein, Peter B. Borwein and Simon Plouffe, "The Quest for Pi", *Mathematical Intelligencer*, vol. 19, no. 1 (Jan. 1997), pg. 50-57.
35. David H. Bailey, Jonathan M. Borwein and Richard E. Crandall, "On the Khintchine Constant", *Mathematics of Computation*, vol. 66 (Jan. 1997), pg. 417-431.
36. David H. Bailey, Peter B. Borwein and Simon Plouffe, "On The Rapid Computation of Various Polylogarithmic Constants", *Mathematics of Computation*, vol. 66, no. 218 (Apr. 1997), pg. 903-913. This paper has been accessed thousands of times from various web sites, and it is mentioned on numerous web sites and in other references dealing with the computation of pi. See for example <http://www.mathsoft.com/asolve/plouffe/plouffe.html>
37. David H. Bailey, "Onward to Petaflops Computing", *ACM Communications*, vol. 40, no. 6 (Jun. 1997), pg. 90-92.
38. David H. Bailey and Simon Plouffe, "Recognizing Numerical Constants", *Canadian Mathematical Society Conference Proceedings*, vol. 20 (1997), pg. 73-87.
39. David H. Bailey, Rupak Biswas and Rob Van Der Wijngaart, "NAS Applications and Advanced Architectures", NAS Technical Report NAS-97-031, NASA Ames Research Center, Nov. 21, 1997.
40. David H. Bailey and Simon Plouffe, "Finding New Mathematical Identities via Numerical Computations", *ACM SIGNUM*, Vol. 33, No. 1 (Jan. 1998), pg. 17-22.
41. David H. Bailey, "Challenges of Future High-End Computing", in *High Performance Computer Systems and Applications*, Jonathan Schaeffer, ed., Kluwer Academic Press, Boston, 1998.

42. Helaman R. P. Ferguson, David H. Bailey and Stephen Arno, "Analysis of PSLQ, An Integer Relation Finding Algorithm", *Mathematics of Computation*, vol. 68 (Jan. 1999), pg. 351-369. The PSLQ algorithm has been selected as one of ten "algorithms of the century" by the editors of *Computing in Science and Engineering*. See paper 46 below.
43. David H. Bailey and David J. Broadhurst, "A Seventeenth-Order Polylogarithm Ladder", submitted for publication, 1999.
44. Ji Wang, P. C. Y. Lee and David H. Bailey, "Thickness-Shear and Flexural Vibrations of Linearly Contoured Crystal Strips with Multiprecision Computation", *Computers and Structures*, vol. 70 (1999), pg. 437-445.
45. Adrian T. Wong, Leonid Oliker, William T. C. Kramer, Teresa L. Kaltz and David H. Bailey, "Evaluating System Effectiveness in High Performance Computing Systems", manuscript, Nov. 1999.
46. David H. Bailey, "Integer Relation Detection", *Computing in Science and Engineering*, Jan./Feb. 2000.
47. Adrian T. Wong, Leonid Oliker, William T. C. Kramer, Teresa L. Kaltz and David H. Bailey, "System Utilization Benchmark on the Cray T3E and IBM SP", *Fifth Workshop on Job Scheduling*, May 2000.
48. David H. Bailey and Jonathan M. Borwein, "Experimental Mathematics: Recent Developments and Future Outlook", *Mathematics Unlimited - 2001 and Beyond*, Springer-Verlag, June 2000.
49. David H. Bailey and Richard E. Crandall, "On the Random Character of Fundamental Constant Expansions", manuscript, June 2000.
50. David H. Bailey and Richard E. Crandall, "Random Generators and Normal Numbers", manuscript, June 2000.
51. Adrian T. Wong, Leonid Oliker, William T. C. Kramer, Teresa L. Kaltz and David H. Bailey, "ESP: A System Utilization Benchmark", *Proceedings of SC2000*, to appear, Nov. 2000.
52. David H. Bailey and David J. Broadhurst, "Parallel Integer Relation Detection: Techniques and Applications", *Mathematics of Computation*, to appear, 2001.